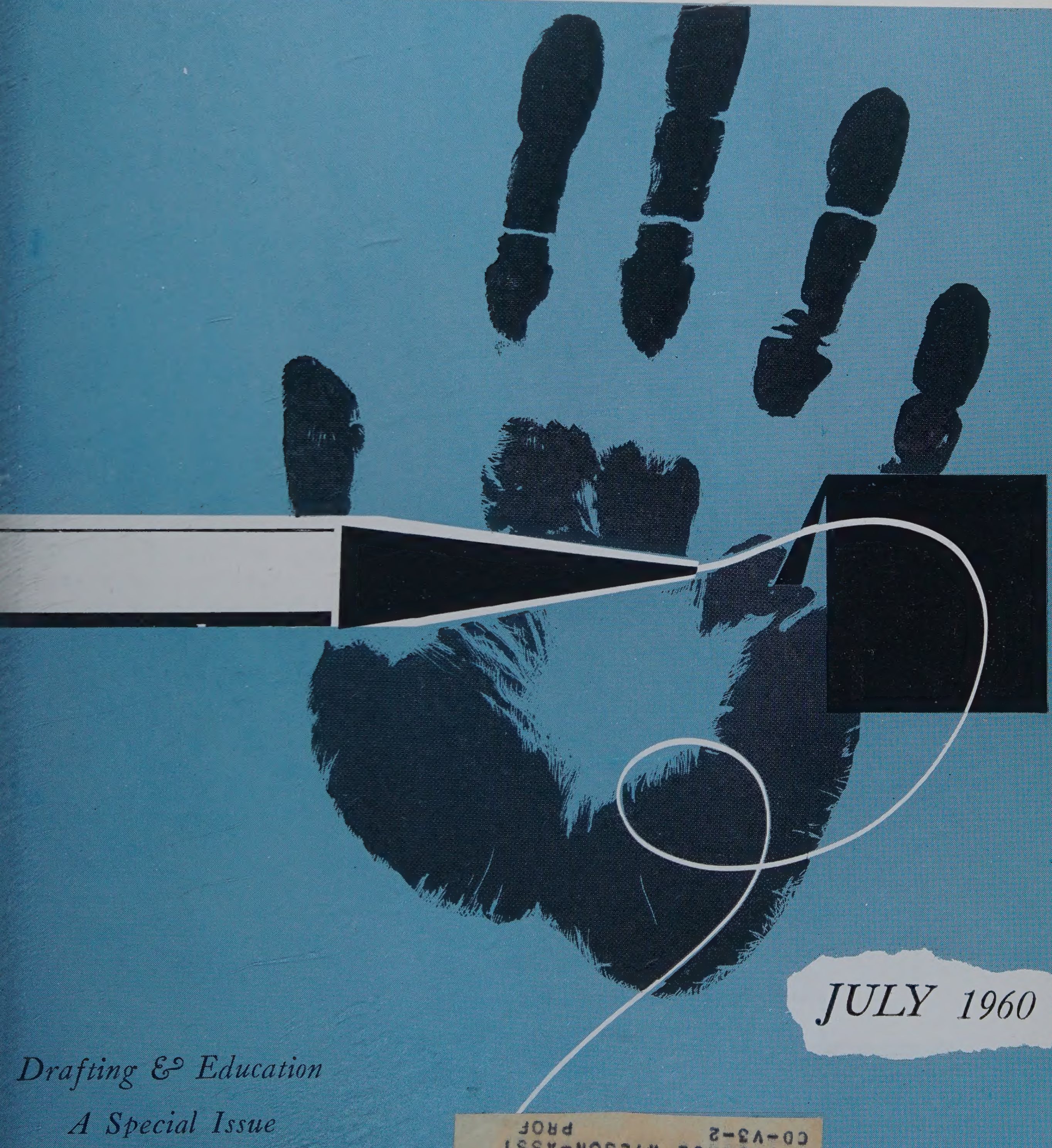
GRAPHIC SCIENCE



JULY 1960

Drafting & Education

A Special Issue

GRAPHIC SCIENCE

THIS ISSUE: 11,750 COPIES

JULY 1960

VOLUME 2 NUMBER 7

The Magazine of engineering drawing management, covering drafting, reproduction and microfilming, technical illustration, drawing standards and drawing filing in all industries.

SPECIAL ISSUE: EDUCATION

ARTICLES

DEPARTMENTS

GRAPHIC SCIENCE is published monthly by Kinelow Publishing Company, Inc., 103 Park Avenue, New York 17, N. Y. (MUrray Hill 5-1745). Charles E. Rhine, president; Paul Yake, vice president; David Z. Orlow, secretary-treasurer. GRAPHIC SCIENCE is published (printed) at 116 Main St., Norwalk, Conn. Address changes, undeliverable copies, and orders for subscriptions should be sent to Editorial Offices, 103 Park Avenue, New York 17, N. Y.

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Letters

Supervision

Sirs:

I have been in the drafting profession since 1943. Starting with a three-year apprenticeship, and continuing on thru the classifications of detailer, draftsman, designer, to my present position as assistant chief draftsman, for the past three years.

Included in my job functions is, most naturally, evaluating drafting personnel and recommending either reclassifications or merit increases. I believe that most will agree that this is one of the more difficult functions, especially if you try to apply complete fairness to both the individual and the employer.

To do this effectively requires a good technical background, psychology, diplomacy, applying the Golden Rule, and the sheer experience of handling people. If men were machines there would be no problems. There isn't a text available that can be considered a Bible on this subject, so the more articles you can read and select the bits of information suitable to your own conditions, the better you can fulfill your duties.

Consequently, the first article I read in your magazine was "Engineering and Drafting Supervisors" by Mr. George Schmidt. I thought the article was excellent. Also, I noticed in the letters on page four, that two previous articles were presented on supervision. One was on "Procedures for Drafting Supervisors," and the other was "Recruiting and Training of Draftsmen." I would appreciate having a copy of each article.

VERNON J. BLACK

Priority

Sirs:

The enclosed change of address was done only to insure receiving my copies of GRAPHIC SCIENCE before my fellow workers get their hands on it. If I am away from my desk when it arrives someone always spots it and by the time it returns there are reference notes plus dog-eared pages, etc., throughout the issue.

This is well meant and all of that, but I feel that the book is too educational and the articles of such interest that I want to preserve them and keep them in good condition for future reference.

May you obtain high success with this publication and continue the fine articles so far published.

LEONARD A. BLAIR

4705 Pilgrim Rd.
Baltimore 14, Md.

Essentials

Sirs:

I have been fortunate in that I have received GRAPHIC SCIENCE from its initial issue. The many technical and informative articles that have been crammed into your first six issues are an indication that a magazine of this scope will expand to become as necessary to the man on the board as a pencil, angle or scale.

Thank you for a formal recognition of the drafting profession.

HARRY S. SMITH

Senior Draftsman
Project Matterhorn
James Forrestal Research Center
Princeton University
Princeton, N. J.

The Reader Reads

Sirs:

We at ITT Federal Division find your magazine very worthwhile and enlightening. Congratulations on a fine magazine.

Of particular interest was George C. Schmidt's series of articles "Operations and Procedures for Engineering and Drafting Supervisors". Are reprints of this series available? We are presently engaged in a discussion-type training program for drafting supervisors and prospective supervisors. This series would form a very excellent basis for this type of program.

I read with interest your January 1960 issue, in which you have published a letter indicating a desire for the formation of a professional society for draftsmen. Drafting as a profession has long needed such recognition. I would personally like to be instrumental in the formation of such a society, and would appreciate hearing directly from those who share this desire and enthusiasm for this goal.

ROBERT F. CLAYTON

Lead Draftsman
ITT Federal Div.
3200 Wayne Trace
Fort Wayne, Indiana

Technical Writer Reads

Sirs:

In a manner similar to that of Mr. Schear's (June, 1960 issue) I became aware of GRAPHIC SCIENCE quite by accident. Being a Technical Writer, I require up-to-date information on the visual aspects of technical communications. Your magazine certainly meets my requirements in all phases i.e., Management, Drawing Techniques, Training Draftsmen, Drawing Materials and the numerous, everyday working problems which require a well-rounded knowledge of microfilming, filing and reproduction.

It is most helpful for me to know how others approach and solve the problems which, on many occasions confront me. At the next S.T.W.E. (Society of Technical Writers and Editors) meeting, I shall make it my business to inform others in my profession of your magazine.

H. C. PETERSON

Technical Writer
Air Reduction Sales Company
Equipment Engineering and Development Department
P. O. Box 281
Clermont Terrace
Union, N. J.

(Letters to the editor should be addressed to 103 Park Avenue, New York 17, New York. Names will be withheld upon request but all must be signed.)

Procedures for Supervisors

Sirs:

I have received my first copy of your magazine, Graphic Science, and enjoy very much reading this type of literature inasmuch as it directly relates to the particular field I happen to be in.

On page thirty-four of the May issue, under the heading of "The Editor's Board," I notice that mention was made of a series of articles entitled "Operations and Procedures for Engineering and Drafting Supervisors" by Geo. C. Schmidt, Chief Draftsman, Campbell Soup Co., which began in December and was concluded in the April issue.

If it is possible, I would appreciate receiving a reprint of this article or the back issues which relate to this subject.

Please notify me if there is any charge for back issues or reprint, as I would like to obtain a copy of this type of material in order to keep up with conditions and the opinions of other men having problems similar to mine.

V. E. Nicastro

Chief Draftsman
The Annin Company
P. O. Box 22081
Los Angeles 22, Calif.

Drawing Numbering

Sirs:

Mr. R. D. Furay's article "Drawing Numbering Systems" sets out clearly some of the considerations applicable to drawing numbering systems, and his conclusions are in close agreement with recommendations made in the same area in the Overseas Operations Department of International General Electric.

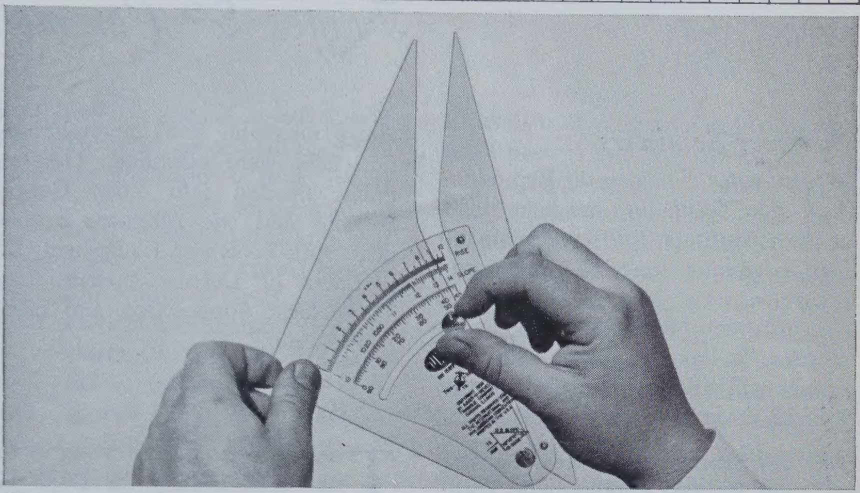
Since I feel that I could simplify my job of advising the engineering managers of our overseas affiliated companies by referring to Mr. Furay's article, I should like to have your permission to reprint it for that purpose.

I'll look forward to getting similar "assists" from future issues of Graphic Science; we are particularly interested in information flow systems, coding, microfilming methods, and microfilming equipment suitable for small operations.

John Perry

Overseas Operations
International General Electric Co.
150 East 42nd St.
New York 17, N. Y.

DRAFTING TRENDS



This versatile, easy-to-handle, adjustable triangle is made of yellow-tinted optical-grade acrylic plastic. A clean-cut oval track fitted with metal knurled knob assures ease of operation and lasting tight fit.

New combination protractor-triangle speeds up drafting

Architects, Engineers, Builders, Field Surveyors, Mathematicians—anyone who develops solutions to measurement problems indirectly to determine a wanted measurement graphically or mathematically—will find the Trig-Matk Adjustable Triangle a handy tool. It eliminates much of the graphic work necessary in estimating results or in checking for correct answers.

Versatility with accuracy

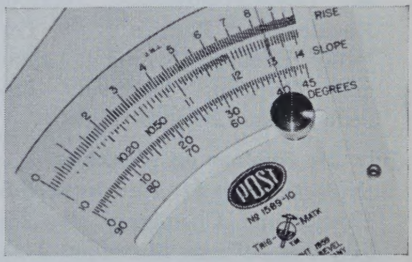
Basically, the new Post Trig-Matk Adjustable Triangle is a mathematician's tool—accurate to two decimal places. It combines the functions of a protractor and a triangle into a simple unit, with two fundamental trigonometric relationships of a right triangle. The Trig-Matk provides accuracy within 1% in problems dealing with any of the six trigonometric ratios of the sides of a right triangle.

The adjustable protractor has three sets of graduations. One set is graduated in half degrees, labeled *Degrees*, and permits the use of the Trig-Matk as a protractor setting for determining any angle from 0 to 90 degrees.

The second set of graduations, labeled *Slope*, shows directly the *Secant* trigonometric ratio of the angle indicated on the degree scale. The third scale, labeled *Rise*, indicates directly the *Tangent* trigonometric ratio shown on the degree scale.

Examples

This new tool has a host of drafting and engineering applications. Highway designers find the Trig-Matk very useful when making cross sections of roadways at ground level or below. By



An indicated angle of 40 degrees on the Trig-Matk (1589) shows directly that the Rise is 8.4 to the base of 10.

setting the *Slope* scale to the degree desired, road-curve grades are automatically determined. The protractor can be used to determine the angle of highway ingress and egress lanes.

Structural Engineers will find the Trig-Matk Adjustable Triangle a simple tool, eliminating the use of both a scale and individual triangles. In addition to the time saved, many of the errors usually associated with the older method are avoided. The Trig-Matk design eliminates the need of frequent reference to handbooks for information on various bevels.

Two Bases

The Trig-Matk No. 1589-12 has a 12″ base for handy calculations in feet and inches. Number 1589-10 has a base of 10 for decimal calculations.

Keep posted on all the latest trends in drafting. Consult your local Post *dealer, or write to Frederick Post Co., 3656 North Avondale Ave., Chicago 18, Ill.*

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

Notes & Comment

Summer Seminars

One-week Seminars in Reproduction Techniques are being held at Ferris Institute, Big Rapids, Michigan, beginning June 13. Each program consists of lectures, discussions, demonstrations and workshop participation. A limited number of applications will still be considered for the July 18 through August 15 Seminars.

July 18: Seminar on Process Camera and Related Photographic Techniques.

Subjects: The Photographic Process, Line Photography, Halftone Negative and Positive Work, Projection Printing, Opaquing, Layout and Stripping, Darkroom Procedures, and Business Aspects.

July 25: Seminar on Microfilm

Subjects: Simple Photographic Physics and Chemistry, 16-, 35-, 70-, and 105mm Microfilm, Making the Negative, Processing Projection Printing, Mil. Specs., etc.

August 8 and 15: Seminar on Reproduction Processes for Shop Foremen

Subjects: Survey of all Reproduction Processes, including Cost Evaluation Discussion.

The fee for each program is $75.00. This includes board and room in one of Ferris' dormitories, supplies for the program, and tuition. Fee should accompany letter of application to:

Jon P. Adams, Dean
Trade and Industrial Division
Ferris Institute
Big Rapids, Michigan

April Meeting

Reporting on its 9th Annual Meeting and Convention held April 19-21 at the Statler Hilton Hotel in New York City, the National Microfilm Association says that attendance surpassed all previous records. Equipment, supplies and accessories for the entire microfilm and microreproduction field were exhibited. The program, divided into Four General Sessions and one Alternate Session, dealt with Tools and Equipment, Department of Defense Specifications, Technology, Applications, and Library Programs.

ASEE

The 68th annual Meeting of the American Society for Engineering Education is being held as we go to press—June 20-24—at Purdue University, Lafayette, Ind. More than 3,000 persons are expected to attend the five-day meetings, at which industrial, scientific and governmental organizations are scheduled for representation, along with colleges and universities.

Next month, look for a first-hand report on these sessions.

Ninth Annual

Standards Engineers Society announces that the Ninth Annual Meeting will be held September 26-28 at the new Pittsburgh Hilton Hotel in Pittsburgh, Penna. Program topics tentatively lined up range from technical writing to the value of decimal dimensioning.

Workshop for Educators

Audio-visual administrators and teachers from colleges and secondary schools throughout Utah, Idaho, and Colorado gained first-hand experience on the use of overhead projection at a recent workshop conducted at the request of the Utah Audio-Visual Instruction Directors Association. The workshop—said to be the first of its kind ever sponsored by a state education department—was presented cooperatively by Ozalid Division, General Aniline and Film Corp., Johnson City, N. Y., and by Deseret Book Co., Salt Lake, Utah.

Nassau 8-

Late in June the Keuffel & Esse Company left its historic quarters at 127 Fulton Street for modernized facilities at 15 Park Row. K&E's new site is 18,000 square fee of floor space formerly occupied by the hardware store of Patterson Brothers. Here, K&E will display a complete stock of engineering supplie and equipment, and will operate one of the most complete reproductio facilities in the New York area.

Way Out West

Move to new headquarters a 26th and Broadway, Kansa City, Mo., has been announced by Charles Bruning Co., Inc., whos home office is located at Mount Pros pect, Ill. Bruning officials said th move reflects the start of a major ex pansion of company activities in Kan sas City and the Southwest.

Correspondence Courses

Engineering drawing courses b mail offered at the Universit of Michigan, Ann Arbor, Mich., hav had good results according to Asso ciate Professor of Engineering Draw ing, Philip O. Potts. In a paper pre sented at the 67th Annual Meetin of ASEE in June 1959, and subse quently published by the *Journal o Engineering Education,* January 196 Professor Potts reports on experienc at the University since 1935, wit both high school- and college-leve courses.

More on Microfilm

Franchised dealer program to pro vide national distribution for it one-step system of processing fo microfilm was announced by Corma Chemical Corp., 80 Fifth Ave., Ne York 11, N. Y., at the Nationa Microfilm Association Convention hel in New York City, April 19-21.

Graphic Perspective

by Eleanor W. Thompson

Editor's Note: Herewith, the conclusion of our guest-written "Perspective" by Frederic G. Higbee begun in the April issue.

To review briefly the development of graphical representation, four rather outstanding periods are evident. The first, antedating 1750 and reaching back into early times, reveals little but a conviction that even in this early day, the value and use of a *graphic* means of conveying ideas was appreciated. The second 100 years were more productive; Monge discovered the science of orthographic projection, early engineers began to use methods commonly used today, engineering education was established, and the teaching of graphic language began. The third period, from 1850 to 1900, witnessed the establishment of drafting as an integral part of the materials of representation.

The fourth and final period, that in which we now find ourselves, is more significant than any. The science of graphical representation is moving toward standardization, its literature is well founded and well defined, its teaching is on a firm basis; its value is recognized, and its use is established in engineering and associated lines.

Great improvements have been made in drafting equipment, drafting room furniture, lighting, and arrangement. New media upon which to draw and to reproduce drawings are constantly appearing and finding a place for themselves. New devices for increasing the output of the drafting room, and the use of photography, indicate that many minds are at work on problems of recording and conveying ideas with greater efficiency and economy.

Among the more significant of these recent developments has been the introduction of so-called production illustration. The principles of pictorial illustration are, of course, among the oldest known graphical methods, and have been in use since ancient times. The recent application of these to production drawings and to the making of "exploded" assembly drawings, and to "cut-away" views to reveal hidden interiors has been a direct result of recent wartime conditions. Forced to find methods for directing inexperienced and untrained workers who could not read engineering drawings, the war industries of England found pictorial drawings an effective means for bridging the gap between the untrained worker and the complications of his job. The importance and worth of this development can be measured by the rapidity with which it was taken up in this country, and its widening use in industry in peace time. Now it appears to be accepted not only as a useful descriptive device for workers, but as a designer's means for study and checking as well.

Thus, as we review the 500 years in the history of graphical representation, we discover that drawing as a means of recording and conveying ideas has made a complete cycle. Pietro, Durer, and Leonardo—artists and draftsmen of notable ability—recognized the limitations of their methods in 1450; draftsmen and industrialists of our time also recognized the inadequacy of the engineering drawing of 1940. And so, at the end of the 500-year cycle, we find these two methods combined.

Teachers of engineering drawing are interested in the future; they have a lively curiosity about the developments in graphical representation which may take place in the period just ahead. As a teacher of engineering drawing, I share both this interest and curiosity; but as a historian of graphical representation -- admittedly of amateur standing—I frankly do not know how to end this discussion.

As a teacher, shall I now remind you that, since its introduction into the engineering curriculum, engineering drawing has been steadily robbed of its alloted time, and that now a new raid is being organized by deans and administrators to provide room for a 20 per cent allotment of social-humanistic studies? Shall I suggest that in the near future engineering drawing may be taught by the art department because draftsmen of the future will be illustrators who know how to read engineering drawings? Shall I invite you to consider a possibility that photography, combined with electronic science, may be developed to a point where entirely new methods of recording and conveying ideas may be devised?

Or shall I, as an amateur historian, ask why it is that so many new ideas and methods, and devices and systems for representation by graphical methods come from without rather than from within the teaching profession? What were the reasons, asks the historian, why engineering drawing teachers failed to point out to industrialists the advantages available from the uses of pictorials? Why do practical men have an attitude about drawing teachers perhaps expressed by the phrase, "An awfully nice chap, but he is a professor!" Is it true that engineers are indifferent to social-humanistic responsibilities?

Questions such as these are food for thought. It is no part of my purpose here to answer them; nor do I propose to make predictions about the future. I shall, rather, repeat what I have stated earlier. Graphical representation is moving toward international standardization; engineering drawing has a well recognized literature; its value is proven; its use is established. Furthermore, it can be stated without fear of contradiction, engineering drawing is better taught, and in less time than ever before.

This article is based on a portion of "The Development of Graphical Representation," by Frederic G. Higbee, published in the **Journal of Engineering Drawing**, May 1958. The article was reprinted in the **Journal** by special permission of McGraw-Hill Book Company from "Proceedings of the Engineering Drawing Division Summer School," conducted at Washington University, St. Louis, Missouri, in 1946.

GRAPHIC SCIENCE

JULY, 196[illegible]

VOLUME 2 NUMBER

If You Were A Draftsman Abroad

In many parts of the world, becoming an engineer out of a draftsman's job without an engineering degree is so rare as to be considered phenomenal

by Irwin Wladaver

LET US SUPPOSE you have always wanted to be an engineer. But for one or more of a thousand reasons—you know them as well as I do—you couldn't go to engineering college after high school. Instead you got a job as a draftsman. And you still want to be an engineer. God knows why, but that's what you want.

Well, what can you do about it? How can you go about becoming an engineer?

In The United States

IF YOU LIVE in the United States you can get the title of engineer in a number of ways. One way is to get a job in an engineering or industrial firm and by watching, reading, asking questions, thinking, and working you can learn enough to assume the responsibilities and to do the work of an engineer. Eventually your company may come across with the title and the reward. Granted that this is the hard way, uncertain and time consuming, yet it is a way.

Nor is it an unusual way. I can name many men with the title of engineer and even chief engineer, men who have never gone to college. For example, one is chief engineer of one of the many plants of a world-wide maker of electrical appliances. Another is the chief engineer in an agricultural machinery factory. There are many others and I'm sure you know a few. And let me tell you a secret: these fellows have struggled mightily to get where they are, and yet they always feel on the defensive. They feel they have to prove themselves all the time, just because they don't have that precious diploma. But they are engineers and they're proud to be. They've done it the hardest way.

Another way to become an engineer is to live near a great metropolis, say New York, Chicago, Boston, Los Angeles, St. Louis, Milwaukee. You can work during the day and you can go to engineering college in the evening. This requires the sacrifice of time, money, energy, and health, but at least it's a way to get an engineering degree. There's one school I know where you could do it in six years, but most schools expect at least eight years. Still, it's a way and if you have the ambition, the guts, the brains—and a cooperative wife—you can do it.

But I repeat: it's a long, tough grind. I remember one of my students who was 45 years old when he started as a freshman. One night as he started for home after a three-and-a-half hour drawing session, he wearily said to me, "It looks as though I'll be getting my diploma in one hand and my Social Security check with the other!" I should add that he was a qualified engineer when h[e] started his degree program; still h[e] wanted the prestige of a degree. Ye[t] he has it now.

Abroad

BUT SUPPOSE you don't live in th[e] United States. Suppose you liv[e] in Italy or Spain, in France, Indi[a], Israel, Great Britain. You're a draft[s]man and you want to be an enginee[r]. Could you? In general, the answer [is] NO, with very few reservations. F[or] example:

In Italy and Spain to get an eng[i]neering degree you would almo[st] surely have to go full time to a un[i]versity or a "politecnico," after su[b]mitting to a difficult competiti[ve] examination. To become an engine[er] out of a draftsman's job without [an] engineering degree is so rare as [to] be considered phenomenal: the id[ea] can be dismissed.

In France, your chances would [be] at least as bad. After waiting three [or] four years, you might pass the rigo[r]ous competitive examination to g[et] into a university faculty of scienc[e]. Or if you are especially gifted y[ou] might get into the Ecole Polytec[h]nique for a tough, two-year scienti[fic] and mathematical program und[er] Army discipline, to be followed [by] two years of specialization at anoth[er] technical school.

(*Continued on page* 26)

ON-THE-JOB training program for selected groups of draftsmen emphasizes active student participation in classroom work.

Training Program for Draftsmen

For more than six years a learning-by-doing course has helped GE draftsmen to master engineering fundamentals at the Meter and Instrument Department in West Lynn, Mass.

by H. C. Dickinson and C. F. Taylor

IN A TYPICAL product engineering group, many people contribute substantially to the technical brain power. Prominent among these are the draftsmen. In addition to preparing drawings for manufacture of a product, they normally contribute much to its design features. Their ability to apply fundamental engineering principles to practical design problems takes some of the workload off the engineer. This ability can be improved through an effective on-the-job training program.

The Draftsmen

THE DRAFTING GROUP in a product engineering activity consists usually of designers and detailers. Design draftsmen are more experienced and creative than detailers. Their job is to apply mechanical designing and drawing skills to a new or redesigned product on the initial layout. After the adequacy of the product design has been verified, the detailers take over and make manufacturing drawings of its parts, assemblies and subassemblies. In this way, the detailers gain the experience and knowledge needed to qualify as future design draftsmen.

The complete product design is, however, basically the responsibility of the development or design engineer assigned to the project. It is he who gets the drafting group started, who makes many of the major engineering decisions, and who works with both design draftsmen and detailers as the work progresses.

Extremely close cooperation between the project engineer and the design draftsman is essential. This is particularly true in the initial layout stage where a large number of mechanical design problems must be solved.

The individual contributions of this engineer-draftsman team are usually hard to measure. But you can be certain that the greater the draftsman's engineering competence, the less the engineer must follow the job, and the more effectively will his advanced training be utilized.

The successful completion of a design project requires the solution of numerous mechanical problems. Many

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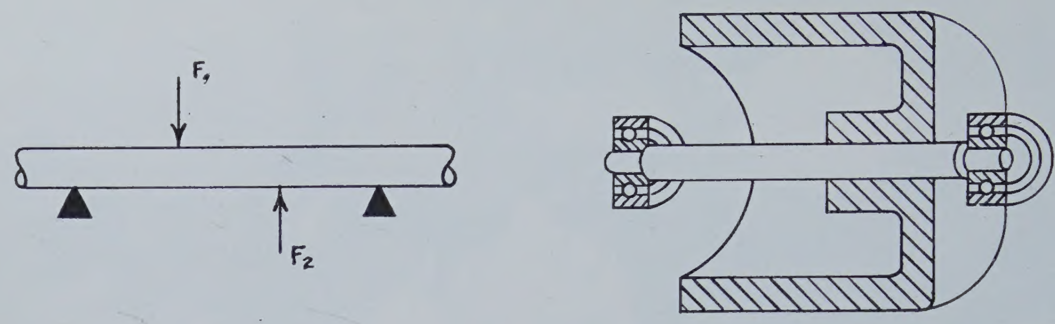
Editor's Note: This description of GE's on-the-job training program for draftsmen is based on the article "Teaching Draftsmen Engineering Principles," published in the **General Electric Review.**



PROBLEM APPROACHES—Academic: What is the maximum fiber stress in the shaft *(left)*? Realistic: Will shaft of gyro-rotor *(right)* withstand severe accelerations?

of these are not even recognized at the time the project is initially conceived. It is the design-draftsman who has the best opportunity to recognize them when he visualizes the design in his initial layout. Because more engineering ability is often needed to recognize such problems than to actually solve them, the design draftsmen's technical background at this stage of the project is a valuable asset.

Fundamentals Wanted

A well organized and effectively conducted mechanical engineering course that applies engineering fundamentals to actual design problems will increase the draftsman's self-confidence. It will arouse his enthusiasm for contributing a larger share to the total engineering activity. And the end result will be accelerated progress for both the draftsman and his group.

One such course taught at General Electric – the Mechanical Design Training Course–has been given to selected groups of draftsmen at GE's Meter and Instrument Department in West Lynn, Mass., for eight years.

When the course was first proposed, we knew that ample preparation and thorough planning would be needed to gain our objectives. At the outset it was decided that the course be set up as follows.

(1) It should cover those mechanical engineering fundamentals specifically applicable to the design of meters and instruments.

(2) It should use the problem approach, employing actual meter and instrument designs.

(3) It should encourage maximum student participation and cooperation.

(4) It should be offered on a voluntary basis to not more than about 20 draftsmen at one time, preferably to those best qualified on the basis of their technical education and design experience.

These requirements meant starting from scratch to determine how much emphasis should be placed on each subject. They also meant preparing a specialized textbook, adapting actual design problems to the proper educational level, and deciding what percentage of the course should be allotted to problem exercises.

The mechanical engineering subjects selected for the course are covered by the academic titles of statics, kinematics, dynamics, friction, strength of materials, and elasticity. Beyond these, however, the resemblance of the course to the conventional textbook approach ends. The student is led into such practical problems as dynamic balancing of gyro rotors, analysis of the forces in an ac ammeter mechanism, design of meter bearings and gears, and the development of instrument and time-switch springs. Relating theoretical concepts to actual product designs in this manner creates a sense of reality for the student. It maintains his enthusiasm and clearly emphasizes the value of understanding fundamental principles.

The technical level of the course is based primarily on the degree to which mathematical and other analytical techniques are used. Most candidates are either graduates of two-year technical schools or have received at least the equivalent amount of engineering training at night school. They have, therefore, been exposed to most of the fundamentals covered and have sufficient training in mathematics to handle the practical analysis of many engineering problems. Still, the time elapsed since such formal training varies with each individual—as much as 15 or 20 years.

The first chapter of the textbook, plus the initial classroom sessions are devoted to a review of algebra, plane geometry, and trigonometry. All reference to calculus is omitted from the course to avoid an added educational burden for, as you know, calculus has a limited practical value in solving certain mechanical engineering problems.

Running for a period of 16 to 20 weeks, the course requires about 10 hours for problem assignments per week, coupled with a weekly two-hour session from 4:00 to 6:00 p.m. It is offered to a selected group of 20 draftsmen on an entirely voluntary basis at no personal expense. Each student participates actively in class sessions, and the instructor can adequately follow each student's progress.

Problem Approach

The instructor, an experienced measurements engineer who pre-

viously taught advanced engineering courses to graduate engineers, spent three months preparing the text and problem material for the course. Other engineers and drafting supervisors helped him select design problems, each involving the maximum number of engineering fundamentals. Designs already developed were picked to assure that the student would deal with realistic problems. Incidentally, this practice also avoids student criticism that assigments represent new work that they would otherwise do during regular hours.

Realistic design problems that reflect conditions as they appeared to the original designer are stressed. The typical textbook approach to the illustrated problem (P. 10, left) is to ask the student to determine the maximum fiber stress in the rod. This requires little more than substitution in a formula. However, in the more realistic problem (P. 10, right), the rod becomes a shaft which is part of a gyroscopic instrument rotor. Here the student is given the severest acceleration expected, and the maximum permissible permanent shift in the rotor's center of gravity. Then he is asked if the shaft is strong enough to meet these requirements.

Mathematically there is little to distinguish these two problems. But educationally there is a profound difference. In the actual problem the student must assume a reasonable factor of safety. He must, among other things, determine the most critical direction of acceleration, plus the region and type of maximum stress. In short, he must put himself in the position of mechanical designer.

To illustrate the application of fundamentals, a large number of realistic problems drawn from actual experience are used in the text and class room lectures, in addition to those assigned as exercises. To meet the needs of the course, however, nearly all have required some adaptation. For example, modifications were made to maintain the proper technical level and to avoid complicated mathematical analysis that would waste classroom and assignment time. Much attention is also given to presenting the problems in a manner that challenges the student's imagination, judgment, and creative ability.

One important feature of the course is developing in the student a critical attitude toward all aspects of a situation—that is, teaching him to recognize those factors that can give him trouble with a design. He is taught to define the problem sufficiently to make an objective analysis, or at least to convey it intelligently to a more experienced member of his engineering organization. Among the techniques we use to stress this recognition factor is to state a problem in this form: "Given a specific design, does it meet specifications? If not, determine dimensions, materials, and other factors so that it will."

Occasionally it is worthwhile to omit vital information in stating the problem. Although this may seem disagreeable—even unfair—to the student, it is certainly realistic. For frequently a disagreement concerning a product design is caused by the lack of vital data needed to draw a sound conclusion. Thus, training the student to spot missing information is a true-to-life exercise of his judgment and ability to perceive actual situations. (The students have more difficulty with the judgment and perception phases of the problem than with the engineering fundamentals or mathematical analysis involved.)

Enrolling Students

Enlisting applicants and selecting students are next in importance to preparing the right kind of text and problem material. An announcement is sent to all draftsmen about two months before the course starts. It describes the objectives, content, and the time required. It also explains how and why a limited number of students are selected. To each announcement we attach an application blank, requesting that the applicant list his education and experience. The following paragraph is also included.

> "While the Mechanical Design Training Course is entirely voluntary and its successful completion will not directly affect the status of any participant, it is a unique opportunity for each of you to increase your effectiveness by learning more about how to apply the general technical knowledge you learned in school to our specific kinds of design problems."

This is followed by a statement that the course will be repeated in future years for those unable to participate in the current term.

The first year the course was offered, applications came from more than half the drafting group—a number far exceeding our set limit. Of these applicants the best qualified were selected by a departmental education committee—a group far enough removed from the drafting supervisors to eliminate any suspicion of favoritism. The committee screened all the applications, personally interviewed doubtful cases, and notified those selected. This was carried on in such a way that successful candidates considered it an honor to be selected.

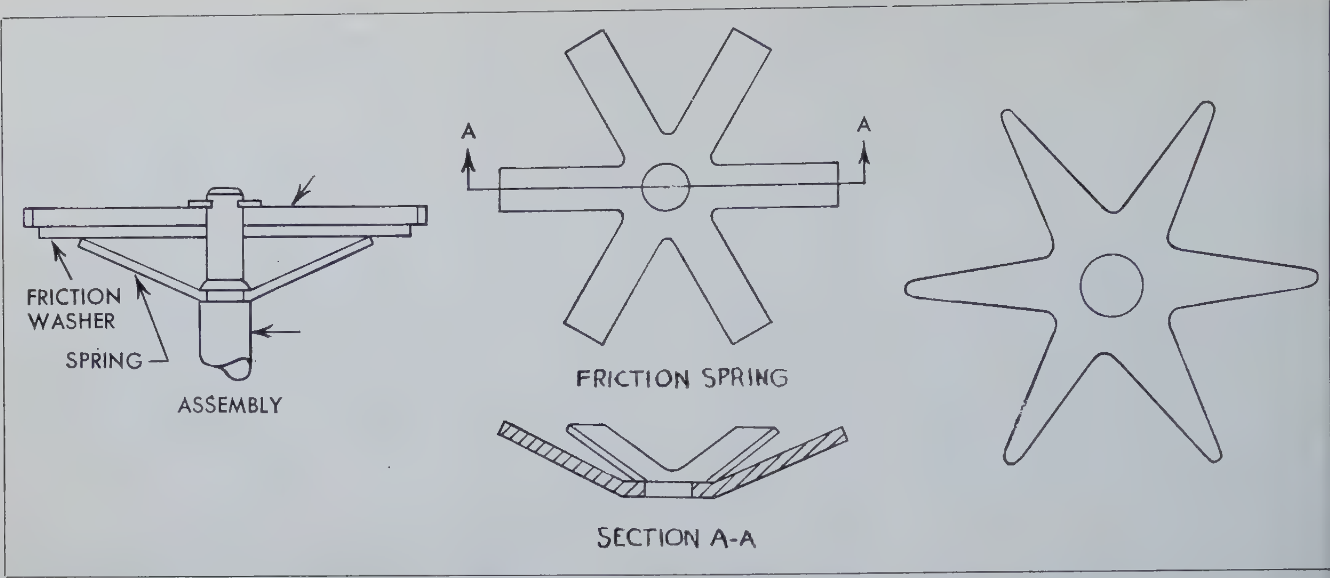
Learning by Doing

The keynote of the course is student participation. Questions and discussions are encouraged at all times during classroom sessions. By introducing controversial points—and asking for opinions on them—the class instructor stimulates such activity.

Normal classroom procedure is a discussion of problem assignments followed by questions on material already covered. Next, new material is presented on fundamentals and their applications to design. By the time the halfway mark of the course is reached—about nine weeks—the students themselves occasionally present parts of the problem for review or discuss the application of fundamentals to their day-to-day work.

More than 80 per cent of the student's time is devoted to problem assignments. We feel that this is the most important feature of the course. For it is the student's chance to learn by doing and to have his results analyzed by the instructor—and frequently by his fellow students. Because no formal examinations are included in the course, this practice allows the instructor to measure the extent to which the student is absorbing his teaching.

About 12 homework problems are assigned during the course, with some extending over a two-week period. To develop cooperative habits and broader viewpoints, the students are encouraged to discuss these assignments with one another and with engineers in the organization. In addition, the instructor is always available for consultation. Here particularly knotty problems are thrashed out, and the instructor himself receives many worthwhile suggestions for improving the course. In fact,



PROBLEM: Design the spring *(center)* for time-switch clutch assembly *(left)*, so that torque variations caused by manufacturing tolerances are minimized. Compare design with spring having tapering fingers *(right)*; justify conclusions by physical reasoning.

several problems used in the latter part of the course were suggested by the students.

Assignments are graded as outstanding, satisfactory, or unsatisfactory. Students are encouraged to rework any problems in the last category, because all assignments must be satisfactorily completed to obtain credit for the course.

Problem Solution

One problem suggested by the students, exemplifying the training provided in the exercise of judgment, involves a time-switch clutch assembly that is to be mass-produced.

In the assembly (illustration, left, above), the friction between the spring and the washer must be sufficient to cause the shaft, on which the spring is rigidly mounted, to follow the gear without slipping. (The gear is driven by a timing motor.) The operating cycle is adjusted by manually shifting the angular position of the shaft with respect to the gear. Variations in friction torque between the shaft-mounted spring and washer must be held to specific limits. The student is asked to design the spring (center) in such a way that torque variations caused by manufacturing tolerances of the various parts will be minimized.

In this problem, the student learns to appreciate that controlling performance characteristics—all critically dependent on uniformity of such properties as mechanical dimensions and coefficient of friction—may be costly, especially in mass production. And because these characteristics are difficult to predict, mathematical analysis tends to be more useful as a guide rather than a firm basis for design. Although formulas indicate relatively critical factors, they do not provide accurate numerical results. For example, the spring force is directly proportional to the thickness of the fingers cubed, to the first power of their width, and inversely to the cube of their length. But when standard manufacturing processes are taken into account, the thickness of the spring stock is the most critical of the three variables.

Next, the student must compare his spring design with the alternative design (illustration, right, above). The basis for comparison is left entirely to his judgment; no mathematical analysis is required, but he must justify his conclusions by physical reasoning. Students find this more difficult than mathematical analysis.

Looking Ahead

Although the initial session of the Mechanical Design Training Course was intended to run for only 16 weeks, it was extended to 20 weeks because of an emphatic appeal by the students for further training. What's more, the second year the course was offered, the number of applicants was—like that of the first year—substantially greater than the previously set limit of 20. In short, it appears to be a popular course.

But to what degree are the benefits and objectives of the course achieved? To get an answer to that question we have to analyze the reaction of the students and the opinions of others in the organization—particularly the engineers. For it is the engineers who are in a position to judge the real effectiveness of the course.

An informal opinion survey of engineers who worked closely with students before and after they completed the course had highly satisfactory results. Typical of some of their remarks were: "It's much easier to get across our ideas." "We got the right answer faster." And, "They spotted some troubles that otherwise wouldn't have been caught up with 'til we made a sample—and maybe not even then."

We can only conclude from such remarks that design draftsmen, as a result of the training they received, are effectively increasing their contributions to the total engineering activity.

The Authors

H. C. Dickinson and C. F. Taylor are both in the Instrument Department, Measurements and Industrial Products Division, West Lynn, Mass. Mr. Dickinson, Supervisor, Engineering Financial Administration, has been with GE for 26 years. Mr. Taylor, an engineer in the Aircraft Engineering Subsection, joined the Company in 1939.

No Ivory Towers Here

A two-year community college tailors its course in Mechanical Technology to meet the needs of local industry

by Paul E. Keicher

One of the many units of the State University of New York, the Mohawk Valley Technical Institute at Utica is a two-year community college whose primary objective is to serve the occupational needs of its community. It provides graduates with the training and qualifications required by local and surrounding industries.

A de-emphasis in the area of graphics, drafting, design, and other related subjects in the four-year engineering schools puts the community college in an excellent position to take the lead in the training of draftsmen and designers for industry. In many four-year colleges, drafting or engineering drawing has been virtually eliminated, and replaced by a two-semester course in Engineering Graphics. This course stresses visualization of spatial concepts and analysis of problems, rather than draftsmanship or technique; and perhaps this is rightly so for certain areas in the engineering profession. The tendency, however, is to reduce the graphics course to one semester, and in some cases to omit it completely from the engineering curriculum. As a result, industry is looking to the two-year technical institute to supply graduates with a thorough understanding of drafting principles, and with the skill required to execute neat and accurate drawings. These graduates must also possess a good knowledge of machine tools, manufacturing processes, metallurgy, and other subjects which are essential background for the designer.

Presently, at the Mohawk Valley Technical Institute, all students enrolled in Mechanical Technology follow a common two-year program consisting of eight, twelve-week quarters; six of these are spent on campus, and two are spent in industry as a part of the cooperative work program. The student receives rigorous training in three basic areas: the field of drafting and design, the field of metallurgy and physical testing, and the industrial field (including such subjects as time study, process engineering, and production planning). The majority of our graduates work in drafting and design. Their training in the two remaining areas — along with basic courses in mathematics, physics, mechanics, and strength of materials— serve to strengthen and enhance the design program. During the six "on campus" quarters, students take three courses in Engineering Drawing, two courses in Tool Design and two courses in Machine Design. In Tool Design and Machine Design, drafting skill and knowledge are combined with design theory in actual design problems involving punches and dies, jigs and fixtures, machines, and machine elements.

The Program

In attempting to meet the needs of the community, the school must work closely with local industries who employ its graduates. We must frequently analyze our program, making necessary revisions related to industrial changes and improvements in production methods. In order to increase our contacts and to further our relations with industry, we have begun the formation of a series of advisory committees. Since the drafting and design program is of prime concern, we began work in that area first. A committee has been formed and is comprised of top men in the field of drafting and design from seven major industries in the Mohawk Valley area. Through a series of meetings with the entire committee and with its individual members, the following drafting program has been formulated which is perhaps unique because it represents a slight departure from the usual course in engineering drawing.

First Quarter

1. Freehand and Instrumental Techniques
2. Freehand Lettering
3. Orthographic Projection
    a. Principal Views
    b. Primary Auxiliary Views
    c. Secondary Auxiliary Views
4. Fractional and Decimal Dimensioning
5. Sectional Views

Second Quarter

1. Blanking and Forming
2. Working Drawings
3. Dimensioning (review)
4. Lettering (review)
5. Tolerancing and Limit Dimensions
6. Threads and Fasteners
7. Welding

Third Quarter

1. Introduction to Tool Drafting
2. Graphs and Charts
3. Alignment Charts
4. Pictorial Sketching

The first two Quarters are devoted to basic principles with which a draftsman or designer should be thoroughly familiar; these are common to most courses in Engineering Drawing, with the exception, perhaps, of Blanking and Forming. Very heavy emphasis is placed on uniform and well proportioned lettering, as this is an area of great concern, continually stressed by the industries with whom we are working. It is considered so important that it not only appears as a formal topic early in the First Quarter, but time is provided in the Second Quarter for a review lecture in which the fundamentals of good lettering are re-emphasized and common errors in technique are discussed. Needless to say,

the student's lettering is continually criticized and good lettering is stressed throughout the entire three Quarters of drawing. Although lettering in a freehand rather than instrumental form is taught, we are considering allowing the student to use a lettering guide or template for his first few lettering exercises. This would enable him to make properly formed letters from the very first. Later in the term when the guide is taken away it is hoped that he will have developed the habit of forming letters correctly and that this habit will carry over into his freehand letttering. This particular approach has been tried by one of the local industries with considerable success, and we feel it has possibilities in our drawing course since we find students even in the Third Quarter of Drawing whose lettering technique is below acceptable standards.

Dimensioning is introduced early in the First Quarter along with Orthographic Projection and is reviewed again in the Second Quarter. Dimensions and notes on a drawing are as important as the views themselves; in some cases they are more important. An early introduction to this topic enables the student to swallow the vast area of dimensioning in small doses and makes him aware of the fact that dimensions are an integral part of a drawing rather than mere trimmings which are added later.

At the beginning of the Second Quarter students receive a brief lecture on the care and operation of the drafting machine. At this point drafting machines of the type encountered in industry are made available to the students not only for the remainder of the drafting course but in the design courses as well. The Blanking and Forming course introduces the student to basic punch press operation and to the peculiarities in drawing and dimensioning parts produced by this method. The remainder of the term is devoted primarily to detail and assembly drawings. The remaining topics, including Tolerancing, Threads, and Welding are introduced at appropriate times and these principles are applied to working drawings as needed. Tolerancing and Limit Dimensions includes definitions of tolerance and allowance, calculations of limit dimensions, and description and application of the various classes of fit. Threads and Fasteners is presented mainly from the standpoint of recognition, specification, and application of thread forms and standard threaded fasteners. Elaborate, time-consuming thread drawings are omitted. Welding consists of about an hour's lecture on the description and use of standard welding symbols.

Tool Drafting, the term adopted here for the lack of a more descriptive one, is basically a continuation of Working Drawings in the Third Quarter. The drawing problems are slanted toward those encountered in tool engineering, consisting of detail and assembly drawings of punches and dies, and jigs and fixtures. The student becomes familiar with tools of this nature and their component parts along with the terminology involved, all of which serves as a foundation for his first course in Tool Design which follows. Charts and Graphs have been included in the drafting course for the first time. Although this area is of little or no importance to the draftsman, it is felt that the technician should have a reasonable knowledge of the subject. Proper technique and plotting procedures – including selection of axes, design of scales, and the drawing of the curve itself—are covered in detail. Further study in this area includes the description and applications of various types of graphs such as the trilinear and polar graphs, as well as the application of rectilinear, logarithmic, and semi-logarithmic graphs to empirical data and equations.

The study of Alignment Charts represents considerable deviation from the average drafting program. The theory of functional scales is applied to the design of the simpler two- and three-variable charts. The more elaborate forms of nomographs are omitted in lieu of the more important phases of the course. The Third Quarter is concluded with approximately three weeks devoted to Pictorial Sketching. As a potential designer, the student should possess the ability to graphically communicate his ideas to others, some of whom may not be familiar with the language of orthographic projection. The mechanics of constructing the various pictorial forms are stressed only to the point of assisting the student in learning to execute a clear, well proportioned, three-dimensional sketch of his ideas.

During the entire three Quarters of Drawing, major emphasis is placed on line quality, which, like good lettering, is of primary concern to industry. Students are urged, in fact severely penalized, for failure to make dark, clean lines that will reproduce well. Reproduction equipment is available to the students, and they soon learn that light lines yield poor reproductions of their drawings. However, good line work cannot be emphasized enough, for we find some students even in the Third Quarter of Drawing who have not acquired the ability to bear down on the pencil.

Courses Not Included

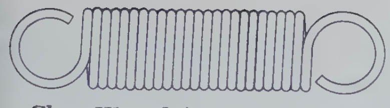
Several topics usually present in the average drawing course or drawing text have been omitted. The philosophy behind their exclusion may be of interest. The Advisory Committee unanimously agreed that inking should be deleted from the drawing course. Industry feels that this is a waste of valuable time, and should the need arise, it can train a person quickly to do this type of work. Shop processes which can be only briefly surveyed in a drawing course are omitted. This area is by far too important to the technician or designer to be brushed over lightly. Actually the student receives intensive training in manufacturing processes, properties of materials, and machine tool theory in other courses throughout the program. Developments and Intersections of Surfaces, otherwise known as Sheet Metal Drafting, is omitted since most of the industries in the area are not engaged in the type of work where knowledge of the subject can be applied. Isometric, oblique, and perspective instrumental drawings are of little or no value as working drawings. Pictorial Sketching, as we have said, is included.

In the final analysis then, we are attempting to create as near perfect a curriculum as possible, one which will adequately prepare a student to enter an industrial career in which he may find suitable employment.

We must be continually aware of the changing picture in the industrial world. We must incorporate the best teaching methods as well as a program geared to meet this changing picture to the best of our ability. Our major responsibility is indeed to the student, since we serve the community best by serving the student.

The Author

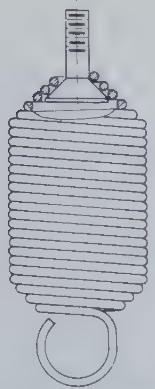
Paul E. Keicher is Instructor in the Mechanical Technology Department at the Mohawk Valley Technical Institute at Utica, N. Y.



a. Close Wound (with initial torsion)

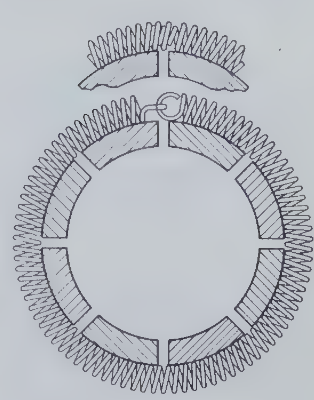
Spring Drafting Principles

b. Open Wound



c. Special Ends

Part II
Extension Springs



d. Garter Spring

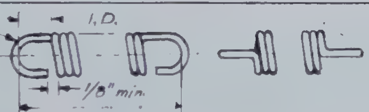
by Albert L. Godshall and Gerald L. Kilmer

HELICAL coiled extension springs store energy by being forcibly stretched along the axis of winding. When permitted to release this energy, they contract in length and exert a pull. The spring ends must be fitted with hooks or other means of attachment to the members being drawn towards each other.

Normal Extension Spring. The body of the normal extension spring can be completely described verbally. Therefore the form for verbally specifying extension springs (Figure II-1) should be used. (Typical figures are shown on the form). Any two of the load requirements listed will establish load characteristics. Specify the two most important. Do not specify more than two as this places impractical limitations on the manufacturer. Service requirements and physical specifications are self-explanatory and should be derived from the application. If the designer's calculations are available, these should be included, to permit the spring manufacturer to check. Use the space provided at the top to illustrate type of ends required or special considerations which require illustration.

SKETCH (END DETAILS)

FOR STANDARD HOOK TYPES, SEE SEC 3, P 4.
INDICATE HOOK OPENING IN SKETCH, IF REQUIRED.



LOAD REQUIREMENTS—SPECIFY ONLY TWO

(AVOID SPECIFYING 4 & 5 UNLESS NO OTHER REQUIREMENTS ARE KNOWN)

1. INITIAL LOAD 6.0 LB. ± 0.5 LB. AT 6.5 IN. LENGTH
2. FINAL LOAD 9.5 LB. ± 0.5 LB. AT 9.0 IN. LENGTH
3. GRADIENT ___ LB. IN. ± ___ LB. IN. BETWEEN ___ IN. AND ___ IN.
   OR ___ IN. ± ___ IN. BETWEEN ___ LB. INITIAL LOAD AND ___ LB. ADDITIONAL LOAD
4. FREE LENGTH ___ IN. ± ___ IN.
5. INITIAL TENSION ___ LB. ± ___ LB.

SERVICE REQUIREMENTS

SPRING MUST OPERATE A MINIMUM OF 10,000 CYCLES BETWEEN 6.5 IN. AND 9.0 IN.
REQUIRED DEFLECTION BEYOND L_2 9.0 IN. (FOR ASSEMBLY, ETC.)
MAXIMUM TEMPERATURE 450 °F.
SPECIAL ___

(LOAD REQUIREMENTS MUST BE MAINTAINED AFTER ABOVE SERVICE REQUIREMENTS HAVE BEEN FULFILLED)

PHYSICAL REQUIREMENTS

MAX. OD .662 IN. MIN. ID ___ IN.
MATERIAL 18-8 STAINLESS (Type 302) FINISH ___
DIRECTION OF WIND OPTIONAL
ANGULAR RELATIONSHIP OF LOOPS { IN LINE ✓ / RIGHT ANGLES / UNIMPORTANT } ± 74 °
HOOK OPENING (SEE SKETCH)

CALCULATED VALUES

WIRE DIA. .059 ±3%* OUTSIDE DIAMETER .651 IN.
FREE LENGTH 4.196 IN. ACTIVE COILS 52.
BODY LENGTH 3.13 IN. GRADIENT 1.4 LB. IN. INITIAL TENSION 2.78 LB.

*FOR DIAMETERS UNDER .034", NOMINAL WIRE DIAMETER MAY BE VARIED .001" SO LONG AS ALL OTHER REQUIREMENTS ARE MET.

REMARKS

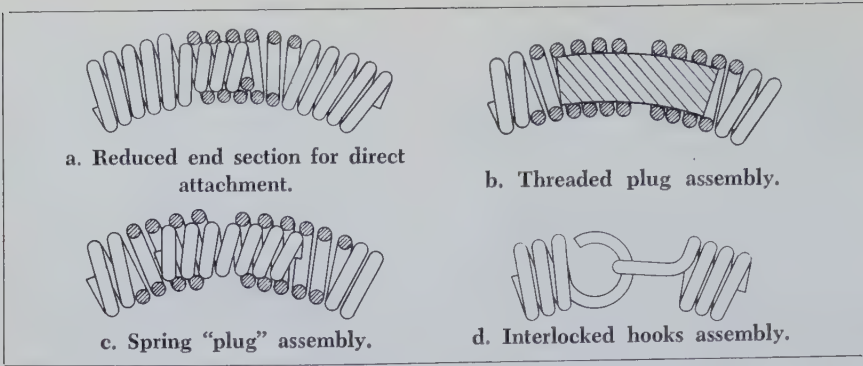
FIGURE II-1. Form for verbally specifying extension springs.

Garter Spring. The portion of this spring where the ends are connected is actually the only part that requires a drawing (Figure II-2). The remainder of the spring can be better explained by notes, in the "Remarks" section of the specification form.

Standard Ends. The type of hook or end used on an extension spring has considerable effect upon the total cost of the spring and it is important, therefore, that careful attention be given to it in designing a spring for a specific application.

Where possible, simple standard ends should be used. The four most common extension spring ends are shown in Figure II-3. These simple ends are low in cost since they can be produced by only one additional operation in the forming of the spring.

Other more complex ends are shown in Figure II-4. Because they are more involved, these ends cost



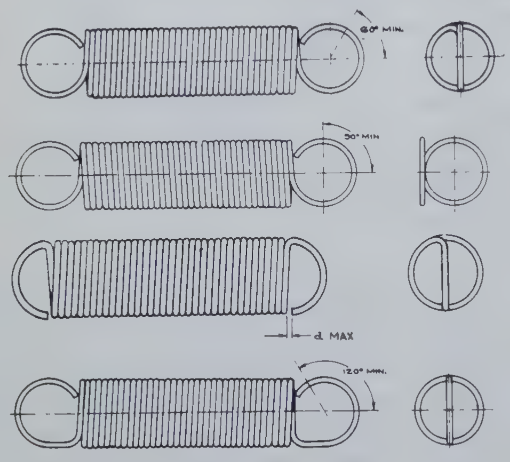
a. Reduced end section for direct attachment.

b. Threaded plug assembly.

c. Spring "plug" assembly.

d. Interlocked hooks assembly.

FIGURE II-2. Typical end connections for garter springs.



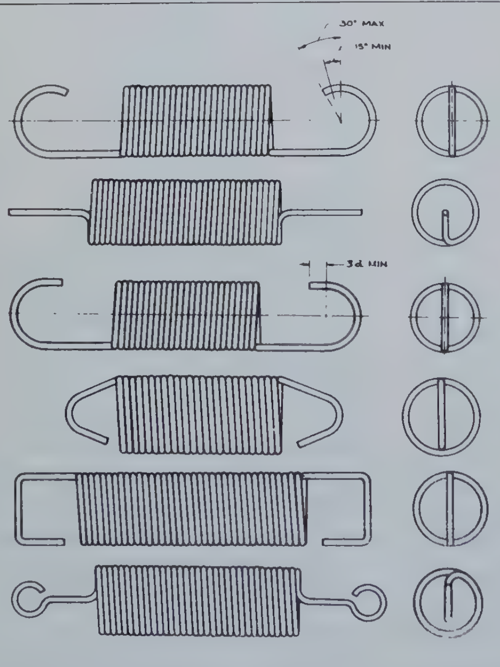
END 1, TWISTED LOOP — Length of loop always equal to ID of spring; recommended for springs with indexes above 15; stresses in sharp bend weaken end at lower indexes.

END 2, FULL LOOP AT SIDE—Similar to End 1, although coil tends to expand slightly; recommended for indexes from 8 to 15; hard on wire due to 90° twist at hook base.

END 3, MACHINE HALF LOOP — Is one-half internal coil diameter from spring body to point of attachment.

END 4, FULL LOOP TO CENTER—Most common type, but is best applied on springs with an index of less than 20; similar to End 3, except loop length is equal to internal coil diameter; cost between this and End 3 is negligible.

FIGURE II-3. Common Extension Spring Hook Ends.



END 5, FULL LOOP EXTENDED TO CENTER—Useful when greater free length is required; costs more than End 4; hook length must be specified.

END 6, STRAIGHT END FROM CENTER —Used when ends are to be clamped; requires specification of lengths of straight ends.

END 7, EXTENDED HOOK — Hook length must be specified.

END 8, DOBBY HOOK—Not common; similar to END 5 but costs more because of special shape.

END 9, RECTANGULAR HOOK—Is expensive and not common.

END 10, HOOK EXTENDED FROM CENTER—Similar to END 6 except for eye on the end; most expensive of types illustrated.

FIGURE II-4. Complex Extension Spring Hook Ends.

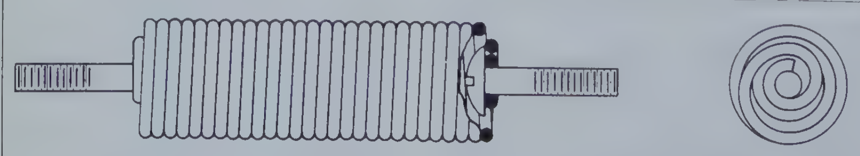


FIGURE II-5. Special Ends must be drawn and fully dimensioned.

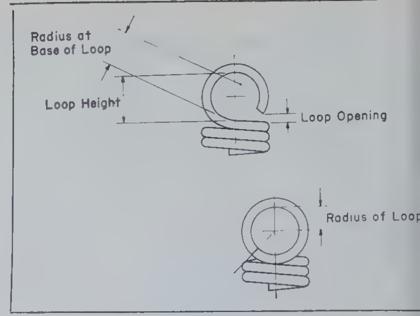


FIGURE II-6. Dimensioning for extension spring ends.

considerably more. However, whe large quantities are involved, it ma be sensible to provide tooling for pro ducing these ends automatically.

The nomenclature used to describ the standard ends shown in Figur II-3 and II-4 is not necessarily tha used by the whole spring industry So in a verbal description, draftsme should use their spring supplier' convention.

All the springs in Figure II-3 an the first three springs in Figure II- can be verbally specified by givin the name of the end and the follow ing four dimensions (see Figure II-6)

(1) Loop height, the distance fro the coil body to the inside of the loo

(2) Loop opening, the distanc from the outer surface of the last co to the extremity of the wire in th hook.

(3) Radius of loop, the radius o the outer semi-circular portion of th end. This dimension need not b given if it is the same as the insid radius of the spring.

(4) Radius at base of loop, th radius of curvature of the initial por tion of the loop as it comes off fro the last coil. This dimension need b given only when there is a fatigu problem.

Note that the first two dimen sions should always be given and tha the last two are required only unde certain circumstances. When end numbered 1, 2 and 4 are drawn, the should show an end view. Ends 8, and 10 of Figure II-4 should b drawn and fully dimensioned.

Special Ends (Figure II-5). All sp cial ends for extension springs shoul be drawn and fully dimensione These include core types and variou types of plugged or swivel hook end which are often used when ordinar hooks tend to break. More expensiv they should be avoided unless larg quantities are required, in which cas tooling can be economically justifie

(*To be Continued*)

Drafting Adrift

Are our schools and colleges turning out a horde of pseudo-scientists certified by degree?

by E. W. Jacunski

When Sputnik I bellowed into orbit in October 1957 its fiery trail whipped across our nation and awakened the people of the United States to some awful educational facts. We had been slumbering under a cloak of complacency in many fields of scientific endeavor. It came as a shock that we were no longer Number One in certain scientific areas, and raised doubts about others.

This realization, like Sputnik's firing stages, came in devastating waves. Not only were we in arrears in our thinking, our scientific progress and our technical accomplishments, but we were exposed as being nearly at the mercy of an ideology that had repeatedly avowed our enslavement and destruction and had from its inception sought to undermine our cherished principles of freedom, individualism and self-government. Nations sharing our concepts and depending on us for protection and leadership were numbed by disbelief.

As a result, an academic upheaval is taking place in all colleges and universities teaching engineering and the sciences. To produce the scientist, curricula are being overhauled. Degree-granting departments feel the pressure of this scientific urge. In their impatience to hurry the student along, they are adding new courses, revising the old, adding more hours to schedules, and de-emphasizing established fundamental core subjects.

In the engineering curriculum, engineering drawing, descriptive geometry, certain design courses, and other courses of an applicatory nature, have for some time been involved in a retreating rear-guard action.

Probably no other course in engineering education has suffered so extensively from the demanding onslaughts for time of the curriculum makers than has engineering drawing. Many colleges fought to maintain the established four-year engineering program at the expense of fundamental core courses. Engineering drawing became a prime target because, in the eyes of non-sympathetic planners, it claimed so much of a student's time—time that, in their opinion, could be better utilized in newer courses. Orders were issued to cut back, revamp and reduce. The die-hard drawing instructors, working as divisions in other departments, or acting as service departments, had very little vote. They made concessions stubbornly but on their own terms. As engineers, they were fundamentalists, and they understood completely the fact that a thorough knowledge of drawing was the basis of engineering proficiency—that this knowledge gave the engineering student his technical eyes.

Consequently, the call for de-emphasis took the form of re-evaluation. The elements of drawing were studied and correlated with the changing demands of industry. Inking plates were reduced; less stress was placed on perfection of lettering and line work; workbooks with partially completed problems came into use; lectures were shortened and supplemented with films; long and tedious assemblies were abandoned and greater stress was placed on sketching. In other words, the luxury of perfection through routine and repetition was eliminated; so was the deadwood that had accumulated over the years within the drawing courses. Engineering drawing became a crisp, accelerated course more closely geared to immediate industrial demands.

The engineering drawing teachers, although bemoaning their loss of time, nevertheless took stubborn pride in the knowledge that some semblance of practical engineering drawing coverage was preserved and that the engineering graduate could be depended upon to read, and possibly, to make a readable sketch and a proper layout if called upon; and that he could intelligently supervise and be critical of his draftsmen.

The coming of the five-year engineering curriculum gave a hint of relief from pressure. It implied that more time would be made available in which to graduate an engineer. New courses in math, electronics, physics and science were hurriedly introduced. Soon, to their dismay, many colleges discovered that added time had not been bought; that all along the four-year program had been graduating 90 to 95 per cent of their engineers in five years. Nothing had been gained but a hatful of new courses.

Again, the cry to cut back, de-emphasize, de-evaluate and eliminate became insistent. The Grinter Report became the administrative bible and a wholesale scramble for the bandwagon began. Sputnik's startling birth added the final impetus. The pseudo-scientist complex has emerged dominant and is being inexorably applied. The function of the engineer has been upgraded and he is being academically appointed to a scientific status, and his course work has been revamped accordingly.

Engineering drawing particularly, as a basic engineering requirement, is being castigated. In some colleges it has been skeletonized and transformed into a reading and sketching course. One college has supplanted it

with a low-level industrial arts course in creativity. Others, under the guise of purification, have combined engineering drawing, descriptive geometry and graphical processes into a one-semester "shotgun" course. Still another offers it as a non-credit remedial course. Pregnant suggestions are afoot that drawing, along with freshman mathematics and chemistry, be relegated to a secondary school level with no obvious thought given to the fact that engineering drawing as a basic engineering course is fundamental and indispensable. It should be taught by experienced engineering personnel familiar with the industrial demands of engineering, and not by teaching personnel devoid of professional experience.

If all become scientific engineers, who will be the applied engineer or the highly trained technician? The technician-engineer-scientist entity is indispensable. The scientist needs the engineer—he in turn needs the technician. One cannot work without the other. The scientific idea without its application and implementation is retarded or completely lost.

The impracticability of producing scientists wholesale is obvious. Not all who aspire are qualified to make the grade, but all those starting should be given a sound training and background in engineering as a foundation. To start specialization on an undergraduate line is not practical. The process should be firm and progressive. The technician will stop at his level; the engineer at his choice, and the scientist, by virtue of his ambitions and abilities, will search out the top-flight schools and graduate institutions for his specialty or specialties. One Einstein, one natural genius, can lead a civilization in its thinking more significantly than a horde of psuedo-scientists certified by a degree.

Industry's Role

Industry more and more is decrying the poverty of fundamental knowledge displayed by our engineering graduates. One industry, upset by the meager training possessed by its young engineers, has discreetly placed certain engineering schools on its discredited list. It no longer sends its recruiters to their campuses. A leading automotive industry compels its new engineers to spend a training period of several months in drafting rooms, thereby orienting them in the overall operational complexities of its organization and repairing their other drafting deficiencies. The young engineer learns early that the real creative engineering is done in the drafting room and that the work of the designer is the keystone of his engineering career. He learns to work with, and to depend on, draftsmen. He learns that in the supervision of their work, his background in engineering drawing must be thorough.

Mr. Charles A. Chayne, Vice-President of the Engineering Staff of General Motors, had the above observation in mind when he wrote, "The most valuable men in an engineering development group are those whose broad background in designing permits them to follow a project from the initial freehand sketch to the finished prototype . . . and certainly a few months of minimum drafting training received in college cannot be considered adequate practice for mastering such a vital skill."

Mr. C. W. Feil, Divisional Chief Engineer of International Harvester Company, looks with alarm at the increasing de-emphasis of drawing. He echoes the words of all practicing engineers when he states, "It is our practice to start many young engineers on the board. I am deeply concerned with the meager training in engineering drawing that some recent graduates have had."

The sad conclusion is that for years to come this training will become more meager. There are freshmen today on many engineering campuses who have become so indoctrinated with pseudo-scientist concepts that they are plagued by the self-image of genius and are convinced that they are destined to work with big new ideas alone and that the rendition of legible drawing will be a job for someone else. They carry this inflated ego into their jobs upon graduation. It is at this point that the able draftsman becomes the engineer's key to success or failure.

To fill the void that the scientific engineer is creating, is a challenge not only to the belabored head draftsman, but to his employer. Already competent, well grounded, intelligent draftsmen are seeing a long-denied opportunity. They are assuming the vacated roles or are taking engineering courses to qualify. Industry is finding a wealth of competency produced by resurgent and vigorously growing technical institutes, concerned with straight - down - the - line engineering courses. More and more, drafting and interpretive ability is being used as a crutch to support the theorist and to insure his design. It is but a matter of time before the technical institute graduate will acquire general engineering stature because of his indispensable proficiency and technical orientation in the field of engineering.

Engineering drawing, as a basic engineering college-level course, can survive only if industry unites in vigorous protest and gives support to its protest by emphatic and positive action. Engineering teachers are in full agreement with the protests of draftsmen, designers, and engineering management, but they are helpless before the current theoretically-minded curricula makers.

Isolated cries of protest have in the past, and will in the future, prove ineffective. Since industry is the terminal objective of the engineering schools and since it must work with the raw material of these schools, it should insist on proper training. Industry must assume its responsibility in this training. Generous and well-publicized scholarships are but a partial answer. This attainment is but a scholastic inducement to a few qualifying individuals rather than to all students.

An Engineering Dean of a Michigan University put the solution bluntly when, at a recent regional meeting of engineering teachers, he pointed a serious finger at a complaining industrial representative and said, "If your company, under its own letterhead, were to inform me, or the president of my university, that you were no longer interested in our engineering graduates because of certain academic deficiencies in their engineering, then by God! you'd get results."

If all industry united in making a joint protest, it, too, would get results and assume its responsibility in the future education of engineers.

The Author

E. W. Jacunski is Head of the Department of Engineering Graphics, College of Engineering, University of Florida, at Gainesville, Florida.

Selecting and Training the High-School Graduate as a Draftsman

The small drafting department at Batelle Memorial Institute sets up a successful training program for four young men

by Ralph L. Paul

ALL DRAFTING supervisors have had the problem of locating competent draftsmen and designers. The fact that a need for such people exists does not have to be argued. At Batelle Memorial Institute, the Mechanical Engineering Department recently planned and carried out an effective training course in order to meet its own need for draftsmen.

Batelle, as you may know, is a research organization conducting contractual research for both industry and government. Drafting activities perform the same function in research as they do in manufacturing: they are the communication system that translates the researcher's ideas into concrete reality.

In our Mechanical Engineering Department, a design and drafting unit of 10 or 12 people operates as a service group for all six of the Research Divisions. Work may come to this service unit as a scanty sketch, or it may be presented as an almost complete layout, representing many hours of thought and study on the part of an engineer. In either case, the drafting unit must develop and complete the layout, contributing its knowledge of materials, purchasable components and manufacturing processes. Once approval of a layout has been secured, the design unit proceeds with detail and assembly drawings so that a prototype device may be constructed in our shops. Our design and drafting personnel work on a variety of projects. Each draftsman must be a potential designer with an inquisitive mind and a readiness to accept any job.

It was the fruitless search for draftsmen and designers who could fit into our organization that led to the planning of the training program described herein.

The Trainees

ALTHOUGH young draftsmen for industry are drawn from a number of sources, in many areas an adequate supply does not exist. A brief survey of these sources and our experience with them will show why we decided to use a training program.

Many of the young men in high schools are exposed to a course in Mechanical Drawing. This is often taught by someone whose major field is not drafting, and students from these courses are not ready to step into drafting jobs. We have had no contact with graduates of the technical high school in our area. Students of the Technical Institute in our city attend school while employed full time; they are not, therefore, available to us upon completion of their studies. Although students who drop out of college engineering courses do prove satisfactory in some instances, they often have a feeling of defeat which prevents them from entering freely into a creative situation.

We decided, therefore, to recruit our trainees from among the high-school graduates. This was the largest single group of men possessing similar backgrounds of education and experience.

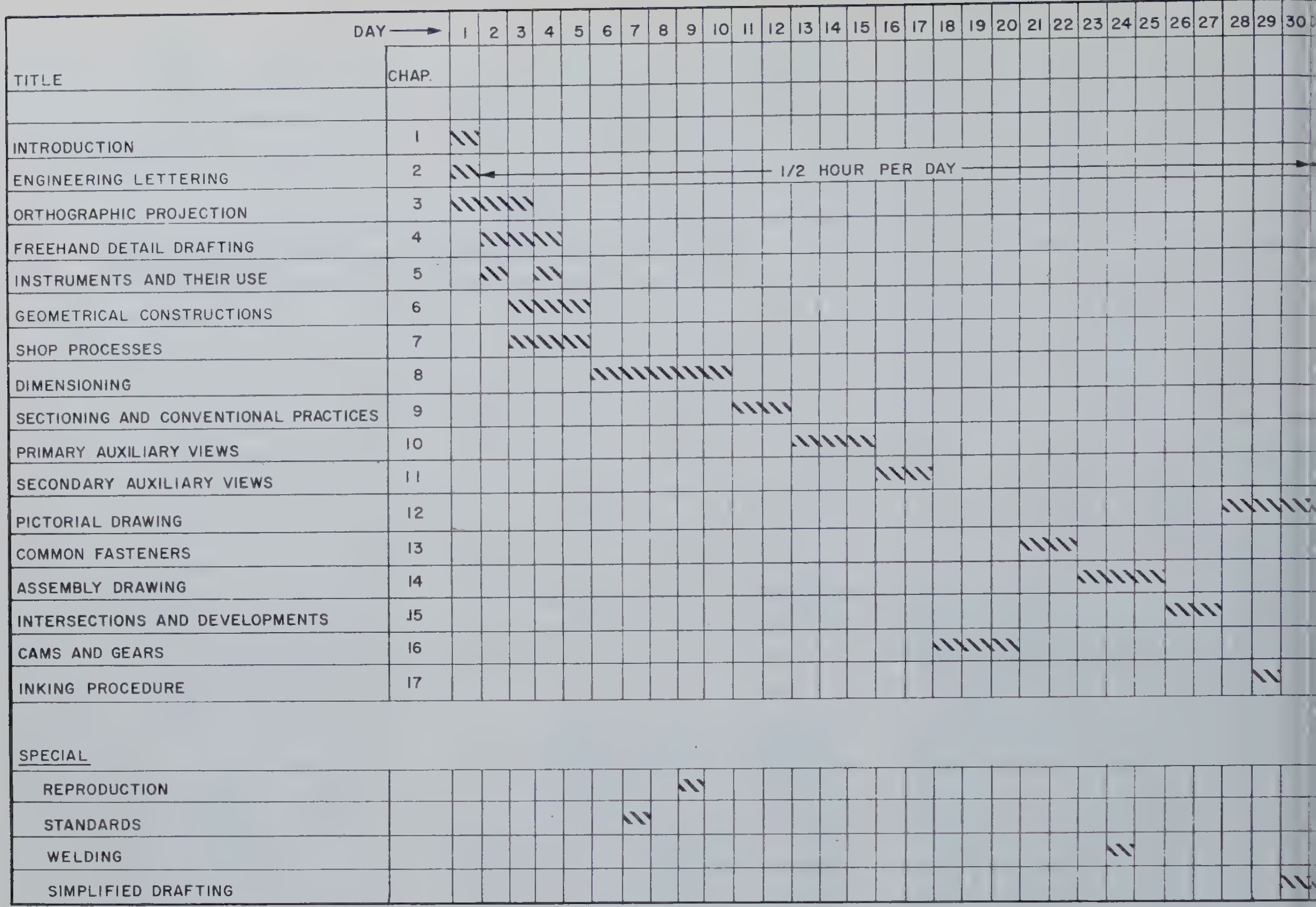
Since much of the success of any training program is dependent upon the proper selection of trainees, a great deal of effort is justified in determining requirements for their selection. We found that four steps were necessary: (1) writing specifications for trainees; (2) determining the number of trainees; (3) securing suitable applicants; (4) selecting best-qualified trainees.

The specifications for our trainees were to be as broad as possible, but at the same time briefly stated. The high-school people we intended to interview had few skills or abilities which could be matched directly with a job description. Three general areas were considered significant: educational background, experience, and outside interests.

Since high-school graduates only were to be recruited, their education backgrounds could be determined on the basis of the subjects they had studied. We specified Mechanical Drawing and requested each applicant to bring samples of his work. Courses in Mathematics were held to be necessary, including Algebra, Geometry, and Trigonometry. Physics, because it imparts some comprehension of mechanics, was deemed particularly desirable, as were shop courses giving the student a knowledge of machine operations. Ability in English was considered valuable because our draftsmen must frequently add notes to drawings. Such compositions, brief as they may be, must be understood by all who use the drawings.

This list of desirable school subjects might be increased or decreased as appropriate for other organizations. We did not require good grades in all of the courses mentioned above, nor, for that matter, that all of them have been taken. The list was a guide, and judgment was to be used in the case of each applicant.

Editor's Note: This article is based on a paper presented by the author at the Engineering Institute on Effective Drafting Management held at the University of Wisconsin, April 7 and 8, 1960.



SIX-WEEK schedule for high-school graduates' training course at Batelle Memorial Institute, Columbus, Ohio.

Experience was the second area considered in writing the specifications. In a training program of the kind we intended to offer, too much experience might be undesirable if it necessitated "untraining." On the other hand, some experience would help the trainee to gain an idea of where he was going. An approximate requirement of one year was set.

Outside interests were the third area. They could tell us something of the nature of the applicant's personality. Did he like such things as model building, hot rodding, photography, or ham radio? These would suggest an interest and curiosity in the new and unusual.

It must be kept in mind that the specifications were only guideposts. Weakness in one area could be more than compensated for by exceptional abilities in another. Judgment was necessary in weighing all the factors.

After the specifications had been written, the next step was to determine the number of trainees. To the number of new draftsmen needed we applied a factor to cover losses because we foresaw that some trainees might drop out or be dropped from the course. We needed two new draftsmen to fill immediate requirements; a class of four trainees was therefore decided upon. For larger groups, a smaller ratio of class size to final number of draftsmen required might be more reasonable.

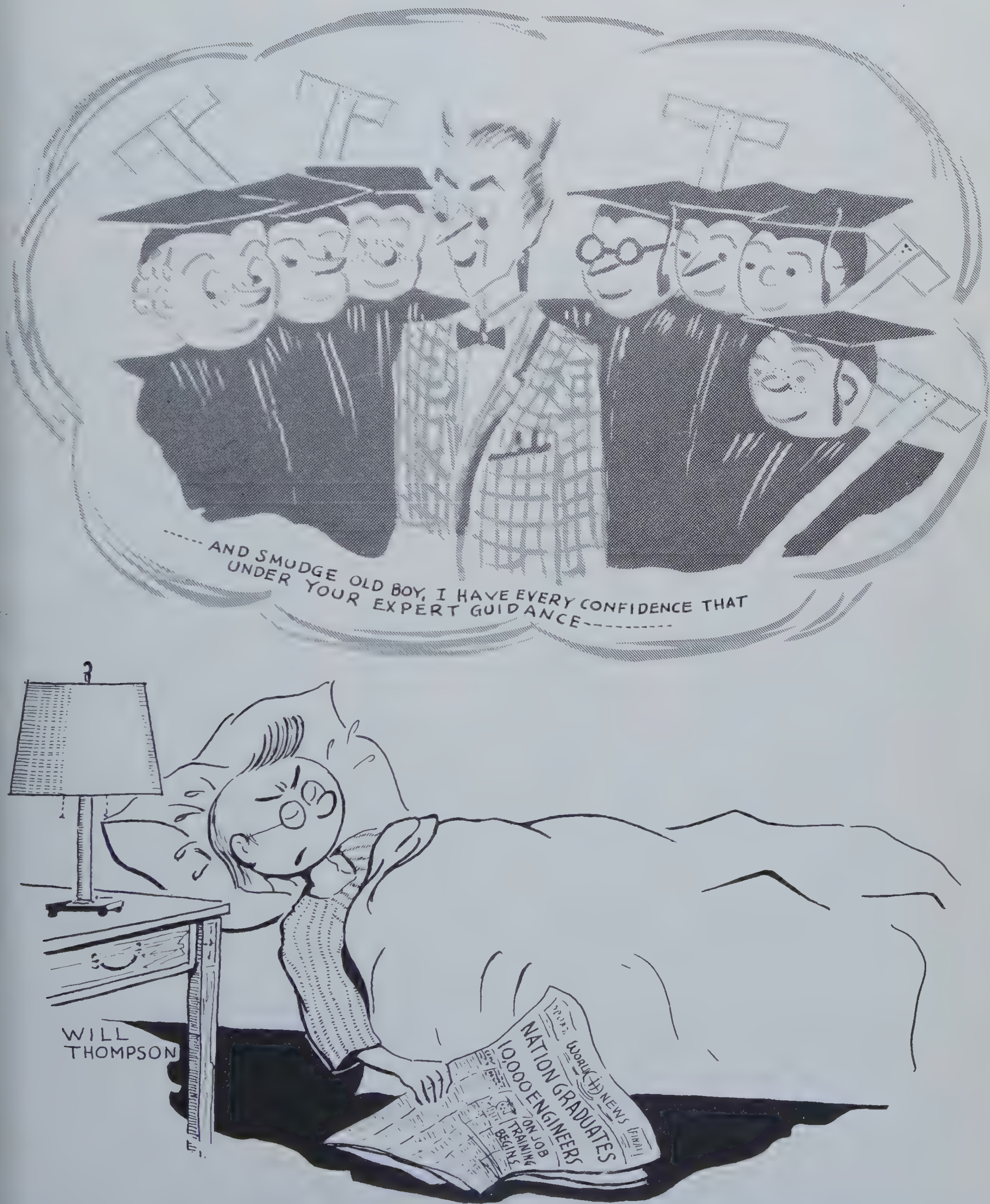
Other factors which helped to determine the number of trainees were space in which to conduct the class and the class load which the instructor could carry without being seriously hampered in his regular duties.

The next step was to secure suitable applicants. We advertised and obtained good results from a two-column ad, four inches high, placed in the "Help Wanted" column of the local newspaper. It brought in about 55 applications. The ad announced the training program, described basic requirements for the trainees, and told a little about the environment in which the trainees would work. Possibly in some organizations a systematic search of the personnel files would yield a number of likely candidates.

Suitable timing of the advertising campaign is important. If the training program is planned to start shortly after the end of a school semester, the advertising should hit the high-school seniors just before graduation when they are thinking seriously about work. Our program started early in February, and the ad brought inquiries from young men who were graduating in January. It also attracted a number of men who had spent six months in military service following graduation.

Our personnel department was a big help in screening the applicants. It eliminated those applicants who did not have the desirable attitudes or interests and others who, for other reasons, might not have been suitable employees. This screening reduced the number of interviews which had to be made by drafting supervision. The personnel department referred about 25 per cent of the applicants to us.

After we had selected the candidates we wished to investigate more thoroughly, we relied largely upon the normal procedures of the personnel department. We requested that about ten of the applicants be given routine employment tests. Six possible trainees remained after the tests, and we listed them in order of preference. We re-


----- AND SMUDGE OLD BOY, I HAVE EVERY CONFIDENCE THAT UNDER YOUR EXPERT GUIDANCE----------
WILL THOMPSON
WORLD NEWS
FINAL
NATION GRADUATES 10,000 ENGINEERS
ON JOB TRAINING BEGINS

quested that the backgrounds of the six applicants be investigated by usual procedures. Once this was done, we made final selection of four trainees.

The Training Course

In undertaking any activity, it is always necessary to establish goals. We established two for our program: (1) To train new draftsmen of better-than-average potentialities and interests, and (2) To create in each trainee an interest in his personal growth toward the status of designer.

It was likewise necessary to establish qualifications for the instructor. He must know the subject of drafting and be well acquainted with the procedures of the organization. Experience in teaching would be valuable. Incidentally, because his activities were essential to the program, we felt it desirable to have him participate in much of the planning.

Next, consideration was given to the textbook and other training materials to be used. Many textbooks are broad in scope, covering a wide variety of drafting fields such as architecture, aviation, and electronics. Since one of the objects of our course was to get the trainees into the drafting room as soon as possible, we decided to limit course work to the topics commonly encountered in our organization. Workbooks, available for use with most texts published, provided challenging problems for each topic. Additional problems were taken from other sources, some from our own drafting room. Other books were made available for reference purposes. Handbooks and catalogs were studied so that trainees would become familiar with these common drafting room aids.

Once the textbook was selected, the course was outlined. It did not follow exactly the sequence of the textbook. For example, because the subject of lettering becomes very tiring if one works at it too long, short periods of not more than one-half hour each were devoted to the subject. Other subjects also were rearranged to fit requirements.

Tests and quizzes were given at the end of each topic to keep the trainees alert and to check whether satisfactory progress was being made.

Although scheduling was necessary to keep the course moving along, the work schedule was not so rigid that adjustments could not be made. Our course ran 8 hours a day for 6 weeks. The day was broken up by spontaneous discussions of problems or drafting procedures and plant tours.

We used an enlarged version of the six-week schedule shown on page 20, with 1-inch squares opposite each topic and beneath each day. In these squares, brief notes regarding assignments and activities were made.

Daily schedules were not made until a day or two before required. This made it possible to adjust the schedule to the progress of the class. The schedule for a typical 8-hour day is given below.

Schedule of Typical 8-hour Day

8:00 Trainees review previous assignment to identify areas requiring additional discussion
8:30 Lettering practice
9:00 Lecture and discussion
- Review of areas in previous assignment requiring additional discussion
- Presentation of new topic with demonstration
- Working of sample problems
- Assignment of problems for new topic
- Assignment of text reading on next topic

10:00 Break
10:10 Unsupervised work period—problems
11:30 Lunch
12:30 Unsupervised work period—problems
2:30 Tour of shop facilities
3:00 Break
3:10 Unsupervised work period—problems and reading in text
5:00 Closing

Note: Instructor may stop at classroom for a few minutes at any time and is available by phone at any time a trainee needs help.

Certain equipment was necessary for the course. These trainees were not taking a high-school course in drawing but were approaching an honest-to-goodness drafting situation, and we realized their need for standard drafting equipment. Tables and machines were set up in a separate room to secure privacy. A chalk board also proved an invaluable classroom aid. Models were very useful. Our shop contributed machine parts showing rounds and fillets, hole configurations, unusual forms, etc. A flanged bushing cut in half illustrated sectioning. A box made of Lucite and hinged at the corners so that the sides could be opened out into a common plane demonstrated projection.

In arranging any training program such as ours, cost is important. Perhaps cost can best be expressed in terms of time. The time expression can then be converted into dollars according to the salary rates involved. According to our schedule, 240 hours would be spent by each trainee before he could begin to turn out productive work. The instructor did not spend all of his time with the trainees, for it was a part of their training to learn to work without constant supervision. This, by the way, seemed to be quite a jump for some of the men. The instructor's time was divided among four activities: preparation, lectures, checking, and personal interviews. It averaged 3½ hours per day, or a total of 105 hours for the 6-week period. This does not include the time spent in the original planning. Cost of books amounted to less than $10.00 per man.

Evaluation

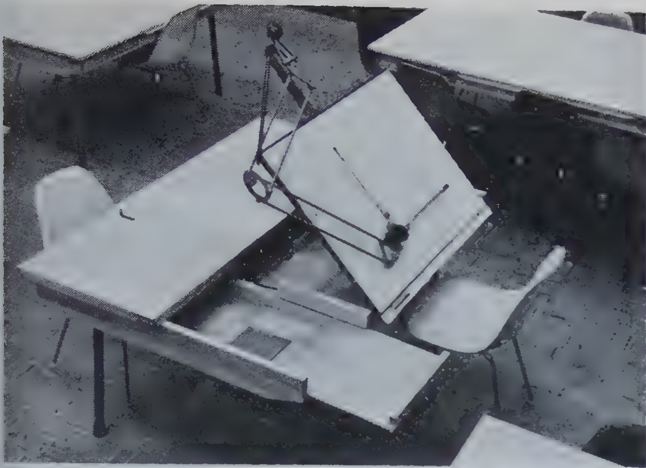
We had early decided that we could count our program a success if two of the four trainees proved adaptable to our work. As the six-week period progressed, it became evident that we did not wish to discharge any of them—yet we could not absorb all four into the design group. Our solution was to assign two trainees to a group of laboratory technicians (integral with each division) and two to the design group, on a rotating basis. This gave all of the men valuable experience, and permitted us to retain them on the staff. One man eventually left to attend college; the other three are still with us, making many contributions to our work.

Three years have now passed since the completion of the course and we have had ample opportunity to evaluate its success. Although precise evaluation is difficult, we believe that our original goals have been met. Our "graduates" appear to have a higher than average interest in their work, and because of this, their potentialities are well utilized. They have also exhibited strong interest in personal on-the-job growth.

We believe that our program, with minor changes, would be successful under most circumstances, and we are considering the possibility of repeating it as we look ahead to future staff requirements.

The Author

Ralph L. Paul, P.E., is Chief Draftsman of the Mechanical Engineering Department of Batelle Memorial Institute, Columbus, Ohio.



Desk-Drawing Tables

Combination units developed for classroom use at M.I.T. economize on space

by Steven A. Coons*

THE DESIGN procedure involves not only drawing, but careful study and analysis carried on concurrently with drawing. The designer needs a desk at which he can study and make computations, write reports, and refer to literature; he also needs a drawing board equipped with a drafting machine. A new style of desk that meets this dual requirement has been developed by Gramercy Guild Group, 116 Broad St., New York 4, N. Y., in cooperation with the Design Division of the Department of Mechanical Engineering at Massachusetts Institute of Technology, Cambridge, Mass.

The desk tops measure 44 by 60 inches; they are hinged in the center as well as along one edge so as to be easy to open. The internal drawing boards measure 26 by 36 inches. The angle of the board is adjustable in increments from about 15° to 75°. Drafting machine linkage is counterbalanced by a spring whose tension is adjustable for any angle of the board. Tops are covered with durable plastic. When used in the open position, there is space for drafting tools and equipment to the left of the board, and the hinged back cover serves as a desk.

At M.I.T. these desks are used to good advantage in drawing rooms that are utilized both for design courses and for freshman subjects in graphics. When used for freshman subjects—taken by the larger number of students—each new drawing desk is occupied by two students who work on small portable boards on the closed desk top. The design course students use the internal boards and drafting machines. There is, incidentally an inducement to the freshman to continue into more advanced courses, in which he will be able to use the more professional equipment. The drafting rooms are also used quite extensively as conference rooms and regular classrooms, since the desks do not by their nature limit their use to drafting alone.

*The author is Assistant Professor of Engineering Graphics at Massachusetts Institute of Technology, Cambridge, Mass.

New Products

Drafting Tables

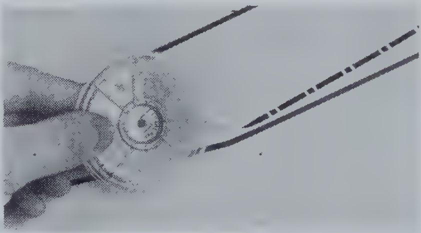
The first major styling change in four-post drafting table design in over 50 years was recently announced by Hamilton Mfg. Co., Two Rivers, Wis. Their new CL 100 Series tables have canted leg design; however, good stability is preserved using front and back crossrails. The drawing board has channeled steel cleats on both ends, and is surfaced with glare-proof linoleum. Catalog, tool, and reference drawers are standard. Board adjustments from 0° to 40° may be made. These tables are offered in four board sizes and two heights.

Broken-line Template

Plastics template providing six different broken-line combinations is offered by dot-N-dasher, Box 668, Cresskill, N. J. The template is applicable to any type of architectural or mechanical drawing where broken-line combinations are required. Its use is said to save considerable time.

Transparent Projection Boxes

Projection boxes, useful in illustrating the planes of orthographic projection, are manufactured in student's and instructor's models by The O. A. Olson Mfg. Co., 712 Tenth St., Ames, Iowa. The boxes consist of flexible, transparent, and colorless plastics planes which can be folded in either direction without breaking the hinges. Accessory devices, designed to help illustrate different types of problems, are optional.



Tape Dispenser

Disk - shaped dispensers, designed for tapes ranging in width from 1/64- to 2-inches, are now available to protect, store and speed application of pressure-sensitive tapes. Manufactured only by Chart-Pak, Leeds, Mass., these Tape-Saver Dispensers are provided to the customer at no extra charge. They are used for packaging Chart-Pak's entire line of narrow industrial, statistical and charting tapes—including "Scotch" brand tapes used specifically for engineering drawings, charts, graphs, printed circuits, etc.

(For additional information regarding the new products described here, contact the manufacturer directly. Complete addresses are included.)

New Literature

How To Instruct, a manual (Cat. No. D 301.7: 50-9. Price-$2.00) written for Air Force Department instructors, is also of interest to others responsible for training employees. It covers instructor's responsibilities, leadership, and personality as well as instructional management and the use of training aids. This publication may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Remittance should accompany order.

Microprojection Papers Brochure, presenting a complete line of papers for microfilm printing jobs, for diazo intermediates, for work prints in black and white from microfilm, may be requested from Anken Chemical & Film Corp., Newton, N. J.

Microfilm Manual, titled *How the United States Army Signal Equipment Corps Makes Use of Microfilm in Preparing Engineering Drawings for World-Wide Distribution,* has been reprinted from Filmsort Facts, and is available on request to The Filmsort Co., Div. of Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 16, Minn.

Microfilm Cameras and Readers Brochure (MIC/5907/2EP), a pocket-fold kit containing specification sheets and price list for Microfax System Equipment, is offered by Eugene Dietzgen Co., Chicago 14, Illinois.

Film Processors Information Sheet, describing the 400 Series Archival Micromatic film processors for 16mm and 35mm film, may be requested from Ana-Tec, Inc., 2054 Granville Ave., Los Angeles 25, Calif.

Chart and Graph Tape Catalog, describing heat-resistant, solid color, and printed tapes for all chart-making and drafting applications, may be obtained by writing to Mico/Tape Inc., 6551 Sunset Blvd., Los Angeles 28, Calif. Twenty-two different patterns in a variety of widths and colors, as well as transparent and metallic tapes, are listed.

The Book Shelf

ENGINEERING DRAWING PROBLEMS, SERIES 1, by Hiram E. Grant, McGraw-Hill Book Company, Inc., New York, 1960 ($4.75)

LONG RECOGNIZED by his colleagues in engineering schools, Professor Hiram E. Grant is an outstanding craftsman in the production of sets of problems in descriptive geometry and in engineering drawing. In the past his drawing problems have been co-authored with Professor H. C. Spencer. The new set, which he designates as Series 1, is a solo product and it is magnificent.

A unique feature of Grant's new offering is that a teacher may use the problems to design a course to suit his own ideas. He is not obliged to adopt the entire set; rather, he may select only those sheets that fit his students' needs or capacities. He can make up a relatively easy, short course—not *too* easy, I must admit—by selecting the simpler problems. If he is lucky enough to have top notch students he can make up a very rigorous course by selecting a different or a larger assortment.

Since, with appropriate exceptions, the drawings are set up on light grids, solutions can be either freehand or instrumental according to the wishes and philosophy of the individual teacher. And since all the problems are taken from industrial prints and then adapted on the basis of sound teaching principles, a potential user of Grant's problems has all the flexibility he could hope for.

Basically there are more than eighty, 10- by 12-inch unbound sheets in the set, packaged in a plastic bag. Some sheets present only one problem; some carry nine small problems. Every type of problem is offered: geometrical construction; normal, inclined, oblique, and cylindrical surfaces; sections; auxiliaries; threads; springs; dimensioning; pictorials, blueprint reading; and so on; all the standard topics you'd expect.

The problems are "keyed," that is, referred to four leading textbooks. This is a valuable feature for students who really want to learn. And to supplement the key, Grant supplies a separate booklet of interesting, auxiliary text material in topics that he feels are not sufficiently detailed in the texts (these, he feels are not the proper province of the texts.) Under certain conditions, the author will provide a set of solutions.

Anyone who conducts a course in a college, technical institute, or private industry can get an examination copy by writing to the publisher or to Professor Hiram E. Grant, Washington University, St. Louis, Missouri.

I. W.

(*Continued from page* 8)

The competition in France is murderous, as I see it. According to the May, 1960 issue of the "Journal of Engineering Education," only one out of 2,200 candidates passes the Polytechnique entrance examination. Some 18,000 other science students don't even try the exam. France does not produce many engineers. You can surmise that the status of engineers there is very high. Promotion from the ranks of draftsmen does not happen.

In India, even if you could qualify to take the entrance examination, you'd have to surpass the grades of 25 other candidates or you wouldn't be admitted to engineering college. Once in, you would be a practically sure thing to get your degree: the big, big problem would be to get in. If you were a draftsman, that's where you'd be entirely likely to stay.

In Israel, the competition for a place as a student in the beautifully located new Technion is very keen and it is the only source of domestically trained engineers. Evening sessions are available and, as in the U. S., it's a long, uphill climb to a degree.

In Great Britain you would have the best chance of moving from draftsman to engineer. You might do it through evening study or through cooperative work-and-study programs conducted by many firms and some assisted by the Government. Or you could move up in your company without a degree, as in the United States. The chief engineer of a London division of an international firm talked with me about this problem while he was showing me the London Works. He told me he was constantly on the alert for technical employees who demonstrated engineering thinking and responsibility on lesser assignments and that he never hesitated to give engineering title and status to such people. But he granted that few men were in positions that allowed such conspicuous performance. On the other hand, the chief engineer of a manufacturing firm in Scotland said that his engineers were all diplomaed because the nature of the work required theory training and that was that.

Nearly half of Britain's supply of engineers comes through work-while-you-learn programs leading to degrees. The up-from-the-ranks engineers without degrees are more plentiful than anywhere on the continent, I believe, but Britain is by no means overrun by such worthy fellows. As far as I can tell, only in the United States is there much mobility from draftsman or technician to the responsibility *and* title of engineer. I'm quite sure that the mobility is likely to decrease.

I think the greatest problem in classifying engineers and their supporting technicians is in settling on a satisfactory definition of engineering. At the margins there are engineers who are doing repetitive and routine jobs, while there are draftsmen who do the finest kind of real engineering design. The machine tool industry in the United States has many such men. In Italy such men would be classified as *periti,* and they are virtually foreclosed forever from engineering titles, even though they carry good status and have every engineer's great respect and very nearly his salary. But the title is beyond the reach of the *perito,* despite the fact that the word in Italian means experienced, skillful, expert. But not engineer.

Opportunity At Home

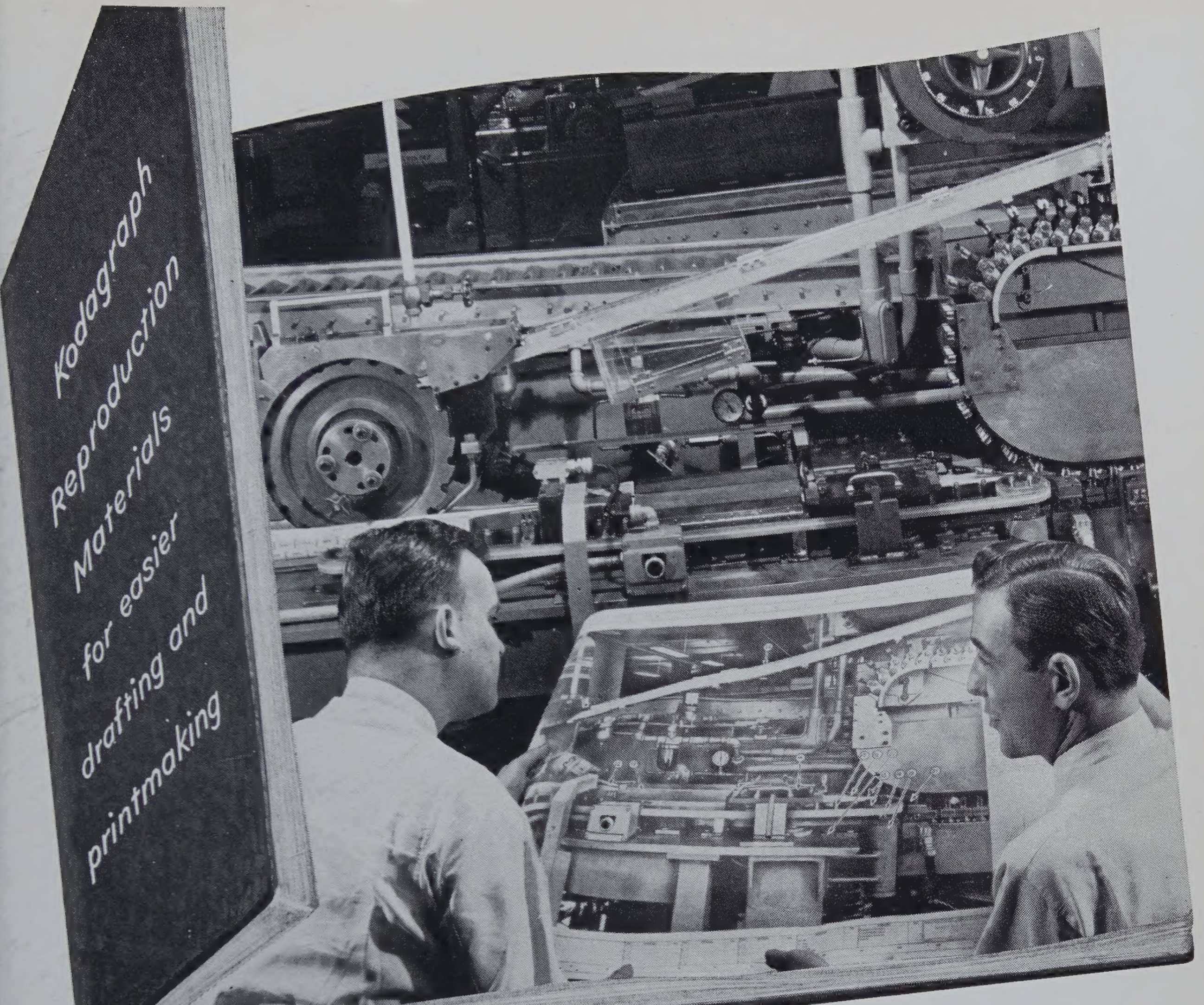
So if you live in the United States you are lucky for more than only political reasons. Here, if you demonstrate your ability you have a good chance of having that ability recognized with the appropriate title and rewarded with a better salary. And if you don't as yet have the knowledge and ability and schooling, there are ways of getting your education and a degree and moving up the scale in that way.

I don't pretend that this is easy. It isn't. But if becoming an engineer is what you want strongly enough you can do it if you work at it hard enough and long enough. You are not held back by conditions beyond your control. Not in the United States.

The Author

Irwin Wladaver, Associate Professor of Engineering Drawing, College of Engineering, New York University and Associate Editor for *Graphic Science,* has just returned from an extended trip to Europe and the Near East. His article is based on first hand observation in many of the countries mentioned.

Advertising Index



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